of the device. Laminated plastic shall be 0.125 inch thick, white with black center core. Nameplates shall be a minimum of 1 by 3 inch with minimum 0.25 inch high engraved block lettering. Nameplates shall be attached to the device in conspicuous location.

2.1.6 Enclosures

Field Electrical Panel (FEP)

Electrical, electronic, and electro-pneumatic devices not located within an ~~FEP~~ shall be mounted in an enclosure unless otherwise specified or shown. Enclosures shall conform to the requirements of NEMA 250 for the types specified. Finish color shall be the manufacturer's standard, unless otherwise indicated. Damaged surfaces shall be repaired and refinished using original type finish. Enclosures for installation in mechanical electrical, and industrial equipment rooms shall be Type 12; those for installation in clean, dry indoor occupied space may be Type 1; other locations as otherwise specified or shown. Enclosures for equipment installed outdoors shall be Type 4 or as shown, and shall contain a thermostatically controlled space heater to maintain the enclosure above the dew point if required by the equipment installed. Enclosures for equipment in hazardous areas defined per NEC code shall be compatible with the classification indicated on the drawings.

2.2 MONITORING AND CONTROL PARAMETERS

The control system shall be complete including sensors, field preamplifiers, signal conditioners, offset and span adjustments, amplifiers, transducers, transmitters, control devices, engineering units conversions and algorithms for the applications; and shall maintain the specified end-to-end process control loop accuracy from sensor to display and final control element. Control equipment shall be powered by a 125 VDC power source, with local transformers included as needed for signal transmission and subsystem operation. Connecting conductors shall be suitable for installed service.

2.2.1 Combustible Gas Detectors

Combustible gas detectors shall be provided for detection of hydrogen in the vacinity of the batteries. They are specified in Section 26 11 14.00 10 MAIN ELECTRIC SUPPLY STATION AND SUBSTATION.

2.2.2 Digital Multi-function Meters (DMMs)

The medium-voltage switchgear uses DMMs for metering. The DMMs shall be connected to the SCADA PLC located in the same equipment via change to protocol converter link.

2.3 POWER QUALITY MONITORING SYSTEM (PQMS)

The PQMS, consisting of, Power Quality Meters(PQMs), communication channels, and PC-based workstation equipment and software, will be used to monitor the power systemt. The power monitoring system shall be a server system utilizing an Ethernet local area network (LAN). In addition to the PQM connection to the PQMS LAN, the SCADA system shall communicate with each PQM via the PLC located in the equipment served by the PQM using a protocol converter link. The PQMS is specified in Section 26 09 13 POWER QUALITY MONITORING SYSTEM (PQMS). The PQM database shall be hosted on the PQMS Serverm. All PQM viewing, trending, printing and interface software shall be installed on the Power Plant Engineering Workstation.

2.4 WIRE AND CABLE, TRANSFORMERS AND TERMINAL BLOCKS

2.4.1 Wire and Cable

Wire and cable jacket material shall be flame retardant PVC, or fluoropolymer as required for the application per NFPA 70. Multiconductor cable shall have an outer jacket. Spare external wiring conductors shall be provided as shown on the drawings.

2.4.1.1 Internal Panel Control Wiring

a. Digital Functions: Control wiring for digital functions shall be 18 AWG minimum with 600 volt insulation.

b. Analog Functions: Control wiring for analog functions shall be 18 AWG minimum with 300 volt insulation, twisted and each pair shielded, 2, 3 or 4 wire to match analog function hardware.

c. Power Supply Functions: Power wiring shall be 12 AWG minimum with 600 volt insulation.

2.4.1.2 External Panel Control Wiring

Wiring for external panel circuits shall be as detailed on Cable Spec Data Sheets included at the end of this section and as shown on the drawings and associated circuit schedule. Wiring application shall coordinate with equipment being connected.

2.4.1.3 Terminal Blocks

Terminal blocks, unless otherwise noted shall be insulated, modular, feed-through, clamp style with recessed captive screw-type clamping mechanism, suitable for rail mounting, and shall have end plates and partition plates for separation or shall have enclosed sides. Analog signal terminal blocks for external panel circuits shall be disconnecting knife-switch type in both the positive and negative signal paths. Digital input terminal blocks for external panel circuits shall have disconnecting knife-switch type in the phase conductor path. Digital output terminal blocks for external panel circuits shall be of the fused-disconnect switch type in the phase conductor path with fuses appropriately sized for the load and to protect the digital output. Digital input source voltage terminal blocks shall be of the fused-disconnect switch type with the appropriately sized for the load and to protect the digital input. Each source voltage terminal block will have a limit of eight input devices.

2.4.2 Transformer

Step-down transformer shall be utilized where control equipment operates at lower than line circuit voltage. Transformer, other than transformers in bridge circuits, shall have primaries wound for the voltage available and secondaries wound for the correct control circuit voltage. Transformer shall be sized so that the connected load is 80 percent of the rated capacity or less. Transformer shall conform to UL 508 and NEMA ST 1.

Transformer will have breakers for protection, not fuses.

2.4.3 Nonconducting Wiring Duct

Nonconducting wiring duct in control panels shall have slotted sides, snap-on duct covers, fittings for connecting ducts, mounting clips for securing ducts, and wire-retaining clips.

2.5 PROGRAMMABLE LOGIC CONTROLLER (PLC)

2.5.1 PLC General Requirements

PLCs shall be micro-processor based, capable of receiving discrete and analog inputs and, through programming, shall be able to control discrete and analog output functions, perform data handling operations and communicate with external devices. PLCs shall meet the requirements of Class A computing devices, and shall be labeled as set forth in 47 CFR 15 and shall be able to withstand conducted susceptibility test as outlined in NEMA ICS 1, NEMA ICS 2, NEMA ICS 3, and IEEE C37.90.1. PLCs shall function properly at temperatures between 32 and 122 degrees F at 5 to 95 percent relative humidity non-condensing and shall tolerate storage temperatures between minus 40 and plus 140 degrees F at 5 to 95 percent relative humidity non-condensing.

2.5.2 Modular PLC

PLCs shall be based on a modular, field expandable design allowing the system to be tailored to the process control application. The system shall be expandable through the use of additional hardware and/or user software. As a minimum, the PLC shall include a mounting backplane, power supply module, central processing unit (CPU) module, communications module, and input/output (I/O) module. The modules shall be grouped together in a mounting rack or cabinet. The mounting rack backplane shall provide the communications mechanism to fully integrate the individual modules located within the rack. Modules shall plug directly into the backplane. The use of wire connectors between modules will not be allowed. The rack size shall be as needed to hold the equipment necessary while performing the required control functions. The system configuration shall allow for the removal and/or installation of modules under power.

2.5.2.1 Central Processing Unit (CPU) Module

The CPU module shall be a self contained, microprocessor based unit that provides time of day, scanning, application (ladder rung logic) program execution, storage of application programs, storage of numerical values related to the application process and logic, I/O bus traffic control, peripheral and external device communications and self diagnostics.

Reference Paragraph System Wide Sequence of Events (d) for timing resolution.

2.5.2.2 Communications Module

Modbus as the

The communications module shall allow peer-to-peer communication with other PLCs and shall allow the PLC to communicate with the central station, or workstation. The communication module shall utilize the ~~manufacturer's~~ standard communication architecture and protocol, ethernet architecture and protocol or a combination of these. The communication module shall allow programming of the PLC to be done locally through the use of a laptop computer or from the central station or remote workstation.

2.5.2.3 Power Supply Module

One or more power supply modules shall be provided as necessary to power other modules installed in the same cabinet. Power supply modules shall plug directly into the backplane. Auxiliary power supplies may be used to supply power to remote cabinets or modules.

a. The power supply module shall monitor the incoming line voltage

values of accumulator inputs or PA input rates that are outside defined limits as specified and shown. PA totalized values shall be compared to predefined limits and alarmed each time a value enters a limit condition. Unique limits shall be assigned to each PA point in the system.

2.6.3.4 System Wide Sequence of Events

System wide sequence of events functionality shall be provided. The sequence of events functionality shall provide the following:

a. A time/date stamped position status report of all SCADA monitored breakers. This status report shall be automatically created and stored on a periodic basis. The period shall be user adjustable across a minimum range of 5 minutes to 24 hours. Creation of this report shall also be available at any time with operator commands/initiation.

b. A system wide time/date stamped protective relay sequence of events report shall be compiled and stored periodically from all protective relays that are time synchronized to the IRIG-B time reference. The period shall be user adjustable across a minimum range of 5 minutes to 24 hours. Creation of this report shall also be available at any time with operator commands/initiation.

c. A system wide time/date stamped sequence of events report shall be compiled periodically using SCADA equipment status points. The period shall be user adjustable across a minimum range of 5 minutes to 24 hours. A means of automatically and chronologically integrating this report with the protective relay sequence of events report identified above shall be provided. Creation of this report shall also be available at any time with operator commands/initiation.

d. System wide time/date stamp devices require 1 millisecond resolution.

2.6.4 Constraints

2.6.4.1 Equipment Constraints Definitions

Each control point in the database shall have PLC resident constraints defined and entered by the Contractor, including as applicable: maximum starts (cycles) per hour; minimum off time; minimum on time; high limit (value in engineering units); and low limit (value in engineering units).

2.6.4.2 Constraints Checks

All control devices connected to the system shall have the PLC constraints checked and passed before each command is issued. Each command point shall have unique constraints assigned. High and low "reasonableness" values or one differential "rate-of-change" value shall be assigned to each AI. Each individual point shall be capable of being selectively disabled by the operator from the central station.

2.6.5 Control Sequences and Control Loops

Specific functions to be implemented are defined in individual system control sequences and database tables shown on the drawings, and shall include, as applicable, the following functions: PI control shall provide proportional control and proportional plus integral control; two position control shall provide control for a two state device by comparing a set point against a process variable and an established dead band; floating point control shall exercise control when an error signal exceeds a selected dead band, and shall maintain control until the error is within

the dead band limits; signal selection shall allow the selection of the highest or lowest analog value from a group of analog values as the basis of control and shall include the ability to cascade analog values so that large numbers of inputs can be reduced to one or two outputs; signal averaging shall allow the mathematical calculation of the average analog value from a group of analog values as the basis of control and shall include the ability to "weight" the individual analog values so that the function output can be biased as necessary to achieve proper control; reset function shall develop an AO based on up to two AIs and one operator specified reset schedule.

2.6.6 Command Priorities

A scheme of priority levels shall be provided to prevent interaction of a command of low priority with a command of higher priority. Override commands entered by the operator shall have higher priority than those emanating from applications programs.

2.6.7 Resident Application Software

Provide resident applications programs developed in accordance with paragraph Graphical Object Oriented Programming to achieve the sequences of operation, parameters, constraints, and interlocks necessary to provide control of the process systems connected to the control system. All application programs shall be resident in the PLC and shall execute in the PLC, and shall coordinate with each other, to insure that no conflicts or contentions remain unresolved.

2.6.7.1 Program Inputs and Outputs

Use program inputs listed for each application program to calculate the required program outputs. Where specific program inputs are not available, a "default" value or virtual point appropriate for the equipment being controlled and the proposed sequence of operation shall be provided to replace the missing input, thus allowing the application program to operate.

~~2.6.7.2 Failure Mode~~

~~In the event of a PLC failure, the controlled equipment shall continue to function in the failure mode shown on the drawings.~~

2.7 CONTROL PANELS

2.7.1 Components

2.7.1.1 Enclosures

The enclosure for each control panel shall conform to the requirements of NEMA 250 for the types specified. Finish color shall be the manufacturer's standard, unless otherwise indicated. Damaged surfaces shall be repaired and refinished using original type finish. Enclosures for installation in mechanical equipment rooms shall be Type 12; those for installation in clean, dry indoor occupied space may be Type 1; other locations shall be as otherwise specified or shown. Enclosures for equipment installed outdoors shall be Type 4 or as shown. Enclosures for installation in a corrosive environment shall be Type 4X and shall be constructed of stainless steel. Painted steel shall not be allowed for use in a corrosive environment. Enclosure shall be provided with a single, continuously hinged exterior door with print pocket, 3-point latching mechanism and key lock and a

2.10.10 Real Time Clock Synchronization

millisecond

The system shall synchronize each central station computer, real time clock, within one ~~second~~ and at least once per day automatically, without operator intervention and without requiring system shutdown. The central station computer shall automatically initiate a call once per day to the time server to obtain the correct time and date and update the real time clock. The central station computer shall generate a report showing the time difference.

2.10.11 System Reaction

Under system normal heavy load, no more than 2 seconds shall lapse from the time a digital status alarm or analog alarm occurs at a PLC until the change is displayed at the central station workstation. The total system response time from initiation of a control action command to display of the resulting status change shall not exceed 3 seconds under system normal heavy load conditions, assuming a zero response time for operation of the PLC's control device. The alarm printer shall continue to print out all occurrences, including time of occurrence, to the nearest second. All system normal heavy load conditions shall be introduced to the system via AIs and DIs.

2.10.11.1 Occurrence

System normal heavy load conditions are defined as the occurrence throughout the system of a total of three status changes, three digital alarms, three analog high or low limit alarms, and three analog quantity changes within the high and low limits during a single 1-second interval. This number of similar occurrences shall repeat on a continuous basis during successive 1-second intervals for a period of 2 minutes.

2.10.11.2 Location

System normal heavy load conditions, as specified, shall have 50 percent of the changes and alarms, including no less than one of each type.

2.10.12 Report Generator

Software shall be provided to generate and format standard and custom reports for displaying, printing, and storing on disk. Reports shall use database values and parameters, values calculated using the real time static database or historical data base; with the reports subsequently stored on hard disk or zip drive. Dynamic operation of the system shall not be interrupted to generate a report. The report shall contain the time and date when the sample was taken, and the time and date when the report was printed.

2.10.12.1 Periodic Automatic Report

The system shall allow for specifying, modifying, or inhibiting the report to be generated, the time the initial report is to be generated, the time interval between reports, end of period, and the output peripheral.

2.10.12.2 Request Report Mode

The system shall allow for the operator to request, at any time, an immediate printout of any report.